Beckman Industrial™

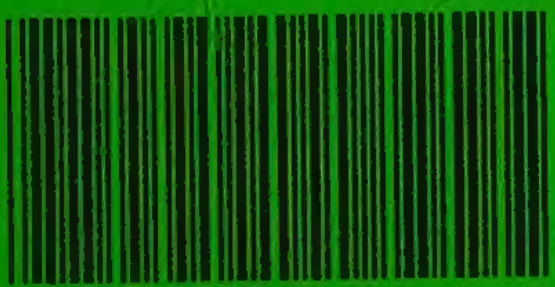
An Affiliate of Emerson Electric Co.

Model 450
Digital Thermometer

OWNER'S MANUAL

MER 10-8954

MP MASTER



MA26570

ONE YEAR LIMITED WARRANTY

The 450 Series Digital Thermometers are warranted against defects in parts, material and workmanship within a period of one (1) year following the date of purchase of the digital thermometer by the original buyer. This warranty is extended by Beckman Industrial only to the original buyer or original user of the instrument who must present proof of purchase at time of warranty service.

In the United States, any instrument claimed to be defective during the warranty period should be returned with proof of purchase to Beckman Industrial's Instrument Repair Department with a $3.00 handling fee. For warranty repair outside the United States, contact your local Beckman Industrial dealer or distributor where your digital thermometer was purchased, or return it to Beckman Industrial's Instrument Repair Department with a $12.00 handling fee.

ANY IMPLIED WARRANTIES ARISING OUT OF THE SALE OF A MODEL 450 DIGITAL THERMOMETER , INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE STATED ONE (1) YEAR PERIOD. MANUFACTURER SHALL NOT BE LIABLE FOR LOSS OF USE OF THE DIGITAL THERMOMETER OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES OR ECONOMIC LOSS.

Some states do not allow limitations on how long implied warranties last or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

CERTIFICATION

Beckman Industrial certified that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory.

450-4311-01B

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SECTION 4: SCHEMATICS

Section 1
Description

1.1 GENERAL DESCRIPTION

Your hand-held, battery-operated digital temperature indicator is configured for compatability with one of the six temperature transducers listed below:

1) Type K thermocouple (Chromel-Alumel)
2) Type J thermocouple (Iron-Constantan)
3) Type E thermocouple (Chromel-Constantan)
4) Type T thermocouple (Copper-Constantan)
5) Thermistor (2252 ohms @ 25°C)
6) Platinum RTD (100 ohms @ 0°C) in a three lead configuration, following the European curve (alpha = .00385)

Each of the configurations linearizes the analog output from the transducer to produce a stable and accurate digital temperature display. Plug-in type input connectors are used for the transducer input to provide quick connect and disconnect capability. The indicator functions are controlled by the keyboard. The liquid crystal display exhibits the value of the measurement, degrees Fahrenheit or Celsius, and the low battery voltage indication.

Through the use of special custom designed intrgrated circuitry, the indicator provides extremely accurate readings and exceptionally long battery life.

1.2 PHYSICAL DESCRIPTION

The indicator measures 45 mm (1.8 inches) in height, 85 mm (3.3 inches) in width, and 145 mm (5.7 inches) in length. Weight is 230 grams (8.0 ounces). The case is constructed of high impact plastic.

1.3 UNPACKING

The indicator is shipped in a special form-fit carton and little need be done to ensure that the indicator has arrived free of shipping damage.

The indicator is supplied with a battery installed. A quick electrical test should be performed to verify that the indicator is operative. See 2.3 in Section 2 for operating instructions.

Contact our Instrument Repair Department immediately if any problems are observed after checking out operation of unit.

1.4 SPECIFICATIONS

Display:

Liquid crystal display, 0.3" (7.6 mm) digit height.

Operating Temperature:

0 to 50°C (32 to 122°F), 0 to 75% Relative Humidity.

Storage Temperature:

-20° to 70°C (-4 to 158°F).

Battery:

NEDA 1604, 9 volt

Battery Life:

Thermocouple - 2,000 hrs. minimum, 3,000 hrs. typical.

Platinum RTD - 500 hrs. minimum, 800 hrs. typical.

Thermistor - 1,200 hrs. minimum, 2,000 hrs. typical.

NMRR:

50 dB @ 50 ± 1Hz or 60 ± 1Hz, 0.1° range.

35 dB @ 50 ± 1Hz or 60 ± 1Hz, 1° range.

CMRR:

140 dB @ 50 ± 1Hz ± 1 Hz 0.1° range.

120 dB @ 50 ± 1Hz or 60 ± 1Hz, 1° range.

Maximum Common Mode Voltage:

1000 VAC (RMS), ± 2000 V peak.

Accuracy at 22°C (72°F):

1° range: ± 0.8°C ± 0.1% rdg.
(± 1.5°F ± 0.1% rdg.)

0.1°range: ± 0.25°C ± 0.1% rdg.
(± 0.45°F ± 0.1% rdg.).

Stability with time:

90 days: add ± 0.05% rdg.

1 year: add ± 0.1% rdg.

Stability with temperature:

Thermocouple: zero; ± 0.03 °C/°C, span; ± 0.02% rdg./°C (max.), reference junction tracking: ± 1.0°C (± 1.8°F) from 5°C to 45°C (41°F to 113°F).

Platinum RTD: ± 0.02°C, ± 0.01% rdg. per °C.

Thermistor: positive readings ± 0.02°C/°C negative readings ± 0.04°C/°C.

TABLE 1. RANGE AND SPAN

Model	Range	Temperature Span
THERMO-COUPLE TYPE K	1°	-189°C to +1372°C -308°F to +2501°F
	0.1°	-139.8°C to +203.7°C -219.7°F to +398.7°F
THERMO-COUPLE TYPE J	1°	-194°C to +1014°C -318°F to +1858°F
	0.1°	-117.4°C to +203.5°C -179.4°F to +398.3°F
THERMO-COUPLE TYPE E	1°	-212°C to +1006°C -351°F to +1844°F
	0.1°	-137.2°C to +203.5°C -215.0°F to +398.4°F
THERMO-COUPLE TYPE T	1°	-217°C to +403°C -360°F to +758°F
	0.1°	-148.2°C to +203.9°C -234.8°F to +399.0°F
PLATINUM RTD	1°	-233°C to +904°C -388°F to +1660°F
	0.1°	-102.9°C to +203.5°C -153.2°F to +398.3°F
THERM-ISTOR	0.1°	-25.7°C to +103.2°C -14.4°F to +217.8°F

Section 2
Description

2.1 PRINCIPLES OF OPERATION

The temperature indicator uses two custom CMOS integrated circuits to digitize and display the analog input signal.

One IC (integrated circuit) performs the conversion of the analog input to the digital equivalent via a dual-slope integrator coupled to a zero-cross detect amplifier. A patented low noise, high gain amplifier is used as an integrator. Battery voltage is also monitored by this IC and a thermistor supplies the reference junction correction signal for thermocouple instruments. This IC uses three low power op-amps for a total current consumption of 30 μA.

The other IC is comprised of LSI digital circuitry, which provides the timing signals for the analog circuitry and senses the axis crossing of the dual slope converter. An internal counter, in conjunction with a ROM controlled binary rate multiplier, performs a piece-wise linearization on the signal. This IC stores the linearized result and directly drives the LCD readout.

2.2 POWER

When battery voltage reaches about 6 volts, the display will exhibit a flashing: "LOW BAT" indication. A minimum of 20 hours of operation time remains upon initial appearance of the "LOW BAT" indication. When the battery voltage drops below 5 volts, an overload indication of three columns of dashes will appear on the display in addition to the flashing "LOW BAT" symbol.

The indicator uses a NEDA 1604 (or equivalent) 9 volt battery. The battery will provide a minimum of 2000 hours of continuous thermocouple operation, 500 hours of RTD operation, or 1200 hours of thermistor operation. To replace the battery, follow these steps:

NOTE: The indicator should be OFF when replacing the battery.

Step 1: Place the indicator face down on a flat surface and remove the four screws located in the recesses or each corner of the case bottom.

Step 2: Carefully pull the case halves straight apart so as not to damage the internal connectors.

Step 3: Install the new battery. Close the case and reinstall the four screws.

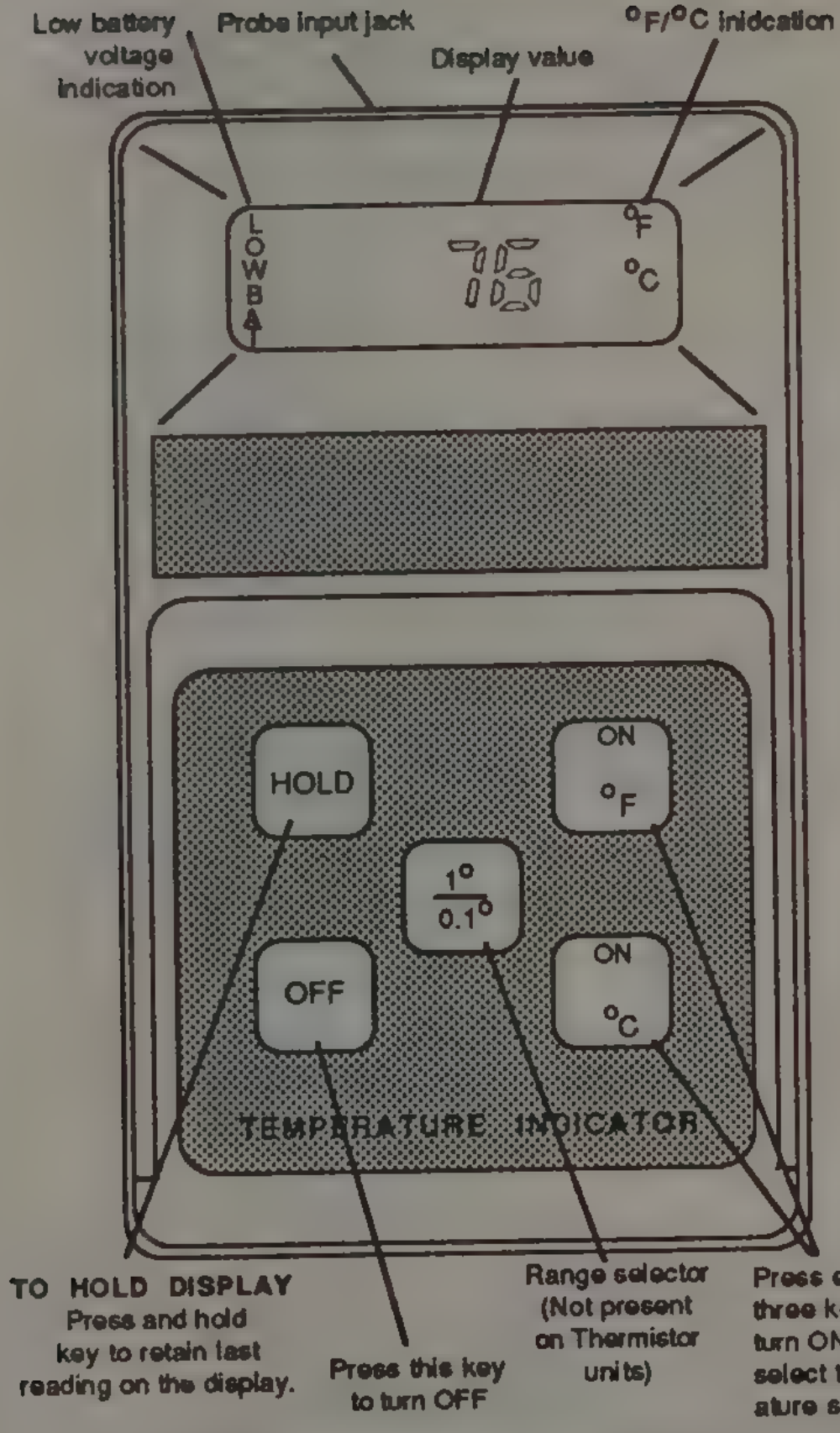
2.3 OPERATION

Step 1: Insert the temperature sensor probe plug into the indicator input jack. Failure to insert a probe results in an overload condition of three columns of dashes showing on the display.

Step 2: Turn the indicator ON by pressing the °F or °C key. The display can be switched to read the temperature in degrees Celsius or Farhenheit without affecting calibration.

Step 3: Select the display range of 1° (wide range, low resolution) or 0.1° (narrow range, high resolution) with the 1°/0.1° key.

NOTE: The thermistor unit has a fixed resolution of 0.1°.



Thermocouple configuration shown

FIGURE 2-0. OPERATION FEATURES

Step 4: By pressing and holding the HOLD key, the last reading will be displayed as long as the HOLD key is pressed. After the key is released, the indicator will revert to its normal displaying mode.

Step 5: Observe and/or record the temperature value.

Step 6: Turn instrument OFF by pressing the OFF key.

2.4 MAINTENANCE

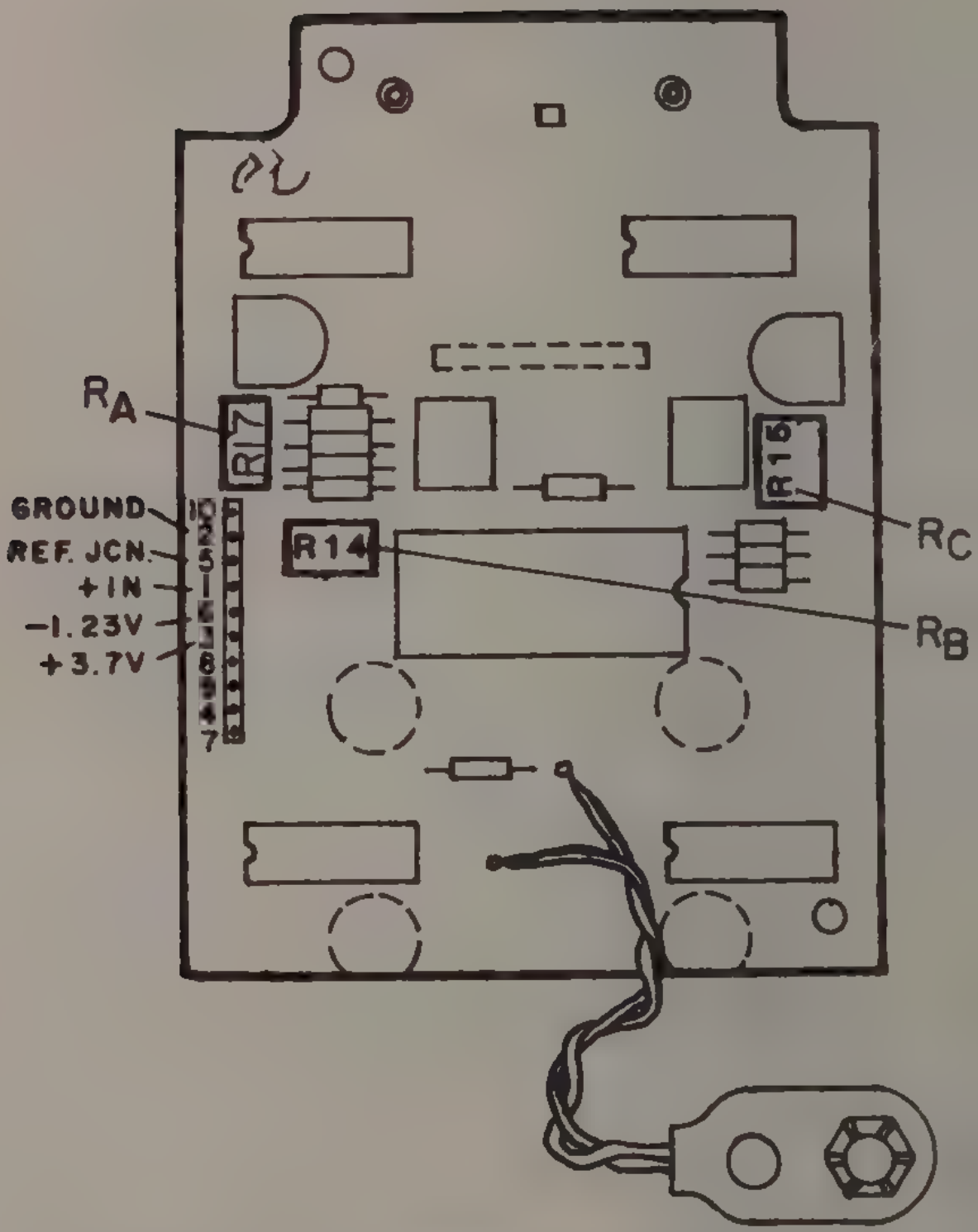
Normal maintenance of the indicator consists of occasional cleaning with a soft, damp cloth replacement of the battery as required, and calibration as outlined in Section 3.

Section 3
Calibration

3.1 CALIBRATION

Complete calibration of the indicator is achieved by performing the Full Calibration Procedure. The Full Calibration Procedure should be performed by qualified instrumentation service technicians. The indicator may be brought to any instrumentation calibration and repair laboratory (metrology lab) for the service (this manual should accompany the instrument). This procedure should be done at least once a year to guarantee continued performance within specifications.

For requirements less demanding and/or if the service facilities are unavailable, the Touch-up Calibration procedure may be performed on all indicator models by the user as required.



Thermocouple configuration shown. Locations for adjustments and testpoints are same for the other models.

3.2 FULL CALIBRATION - THERMOCOUPLE TYPE K, TYPE J, TYPE E AND TYPE T

Equipment List:

4 1/2 digit, digital voltmeter
Voltage Calibrator:
resolution, 1μV; accuracy ± 0.01% (± 2μV).
Ice Bath, 0.00 °C ± 0.05 °C.
Jumper lead terminated in mini-clips.

For optimum results, the calibration should be performed with an ambient temperature from 20°C to 24°C (68°F to 75°F). Refer to Figure 3-1 for locations of all testpoints and adjustments.

a. Turn the indicator ON by pressing the °C key.

b. For Types K, J, E and T units only, switch the indicator to the 0.1° range.

c. Remove the bottom case of the indicator per 2.2.

d. Adjust the voltage calibrator for an output of 0.000mV and connect the minus lead from the calibrator to "GROUND" and the positive lead from the calibrator to "+IN", on the indicator printed circuit board.

e. Disable the reference junction by jumpering together the "REF.JCN." and "GROUND" testpoints, using a jumper lead terminated in mini-clips.

f. Adjust R_B for an indicator display of 0.0C°.

g. Connect the DVM LO lead to "GROUND", on the indicator printed circuit board.

h. Using the HI lead of the DVM, measure the voltage at the "1.23" testpoint; disregarding the polarity indication, record the voltage.

i. Move the DVM HI lead to the "+3.7" testpoint and record the voltage (disregard polarity indication).

j. The voltage measured at the "+3.7" testpoint should be 3.007 times larger than the voltage measured at the "-1.23" test point (for ratio of 1:3.007). Adjust R_C (which varies the +3.7V line) to attain this ratio.

k. Switch the indicator to the 1° range.

l. Adjust the voltage calibrator for an output of
+53.765 mV for the Type K input, or
+57.942 mV for the Type J input, or
+75.983 mV for the Type E input, or
+18.824 mV for the Type T input.

m. Adjust R_A for an indicator display of +995°C for the Type E input, or R_A for an indicator display of + 1000°C for the Type J, or +1340°C for the Type K input, or +367°C for the Type T input.

n. Reassemble the indicator.

o. Perform the zero calibration procedure per Section 3.5.

FULL CALIBRATION COMPLETED

3.3 FULL CALIBRATION - THERMISTOR

Equipment List:

4 1/2 digit, digital voltmeter.
Precision resistance decade box:
resolution, .01 ohm; accuracy ± 0.02%.
Electro Scientific Industries, DB-62 or equivalent.
Ice bath, 0.00°C ± 0.05°C.

Refer to Figure 3-1 for locations of all testpoints and adjustments.

a. Turn the indicator ON by pressing the °C key.

b. Remove the bottom case of the indicator per 2.2.

c. Connect a precision resistance box to the terminals on the input phone jack; set the resistance box to 7,280 ohm.

d. Connect the DVM LO lead to "GROUND" on the indicator printed circuit board.

e. Using the HI lead of the DVM, measure the voltage at the "-1.23V" testpoint; disregarding the polarity indication, record the voltage.

f. Move the DVM HI lead to the "+3.7V" testpoint and record the voltage (disregard polarity indication).

g. The voltage measured at the "+3.7V" testpoint should be 3.007 times larger than the voltage measured at the "1.23V" testpoint (for a ratio of 1:3.007). Adjust R_C (which varies the +3.7V line) to attain this ratio.

h. Adjust R_B for an indicator display of 32.2°F.

i. Set the precision resistance box to 174.62 ohms.

j. Adjust RA for an indicator display of +386.0°F.

k. Reassemble the indicator.

l. Perform the zero calibration procedure per Section 3.5.

FULL CALIBRATION COMPLETED

3.4 FULL CALIBRATION - PLATINUM RTD

Equipment List:

4 1/2 digit, digital voltmeter.
Precision resistance decade box:
resolution,0 .01 ohm; accuracy ±0 .02%.
Electro Scientific Industries, DB-62 or equivalent.
Ice bath, 0.00°C ± 0.05°C.
Refer to Figure 3-1 for locations of all testpoints and adjustments.

a. Turn the indicator ON by pressing the °F key.

b. Remove the bottom case of the indicator per 2.2.

c. Connect a precision resistance box to the terminals on the input phone jack; set the resistance box to 100.04 ohm.

d. Connect the DVM LO lead to "GROUND" on the indicator printed circuit board.

e. Using the HI lead of the DVM, measure the voltage at the "-1.23V" testpoint; disregarding the polarity indication, record the voltage.

f. Move the DVM HI lead to the "+3.7" testpoint and record the voltage (disregard polarity indication).

g. The voltage measured at the "+3.7V" testpoint should be 3.007 times larger than the voltage measured at the "-1.23V" testpoint (for a ratio of 1:3.007). Adjust R_C (which varies the +3.7V line) to attain this ratio.

h. Adjust R_B for an indicator display of 0.2°C.

i. Set the precision resistance box to 148.4 ohms.

j. Adjust R_A for an indicator display of +101.0°C.

k. Reassemble the indicator.

l. Perform the zero calibration procedure per Section 3.5.

FULL CALIBRATION COMPLETED.

3.5 TOUCH-UP CALIBRATION PROCEDURES: ALL MODELS

Touch-up Calibration may be performed by using one of two methods outlined below.

1) The Zero Calibration is the most expedient method and can be done without disassembling the instrument. An ice bath can be provided by filling a wide-mouth quart-sized thermos bottle with cube ice, then adding cold water within 1 inch of the neck opening.

2) The Coarse Span and Zero Calibration is a simple adjustment that corrects reference amplfier errors due to offset drift with time. This procedure requires a 4 1/2 digit, digital voltmeter in addition to the aforementioned ice bath.

1. Zero Calibration

a. Turn indicator ON by pressing the °C key.

b. Set the indicator range to 0.1°.

c. Connect the probe into the indicator input jack.

d. Place the probe in a stable ice bath (0.00°C ± 0.05°C and adjust the ZERO pot (R_B) located beneath the indicator (remove plug) for an indicator display of 0.0°C.

e. Replace the ZERO adjust plug.

ZERO CALIBRATION COMPLETED.

2. Coarse Span and Zero Calibration

Refer to Figure 3-1 for locations of all testpoints and adjustments.

a. Turn the unit ON by pressing the °F or °C key.

b. Remove the bottom case of the instrument in the same manner as when replacing the battery (2.2).

c. Connect the DVM LO lead to "GROUND".

d. Using the HI lead of the DVM, measure the voltage at the "-1.23" testpoint; disregarding the polarity indication, record the voltage.

e. Move the DVM HI lead to the "3.7" testpoint and record the voltage disregarding the polarity indication.

f. The voltage measured at the "3.7" testpoint should be 3.007 times larger than the voltage measured at the "-1.23" testpoint (for a ratio of 1:3.007). If the ratio is not correct, adjust R_C (which varies the +3.7 line) to attain this ratio.

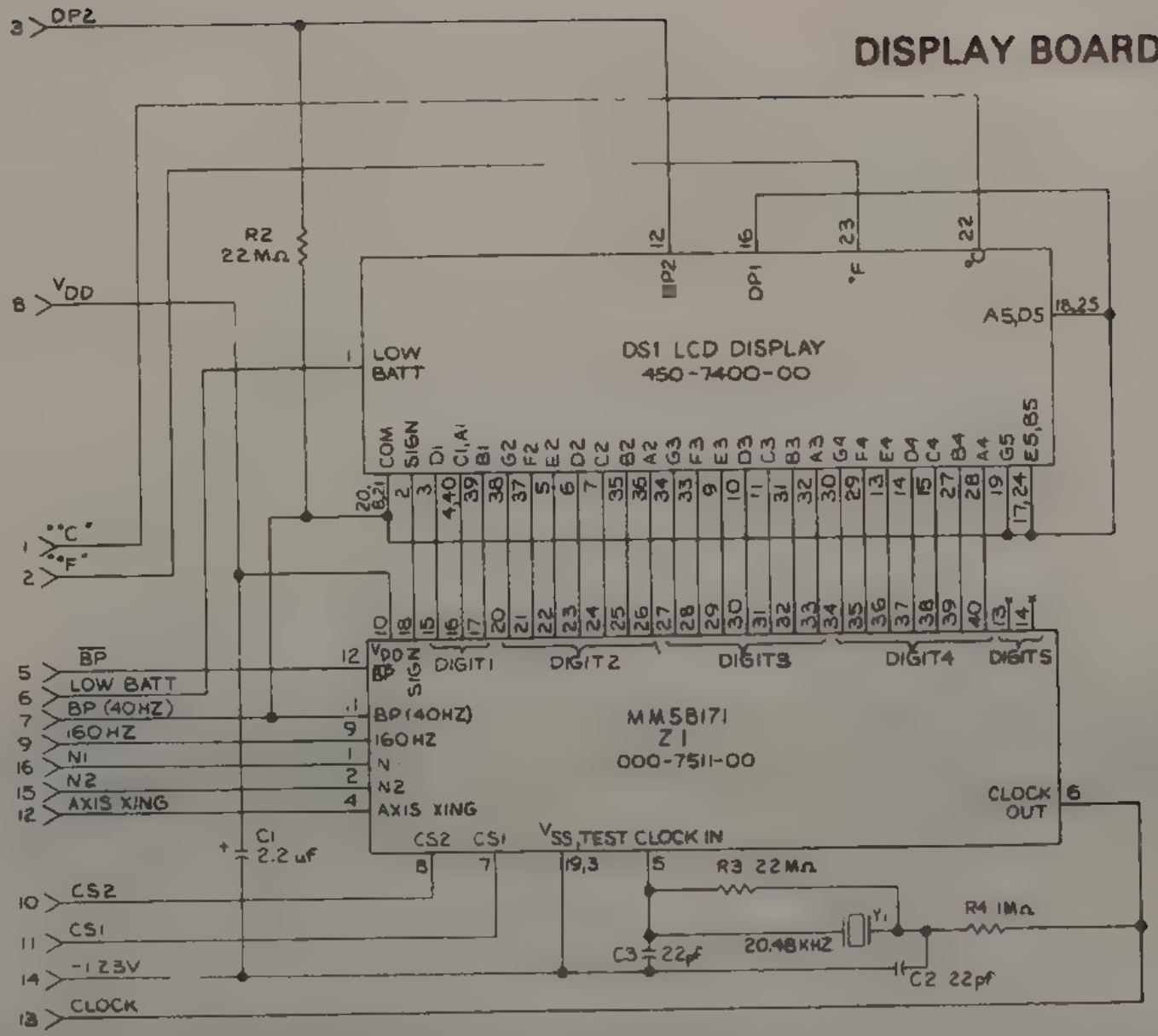
g. Reassemble the indicator.

h. Perform the Zero Calibration procedure per "1" shown before.

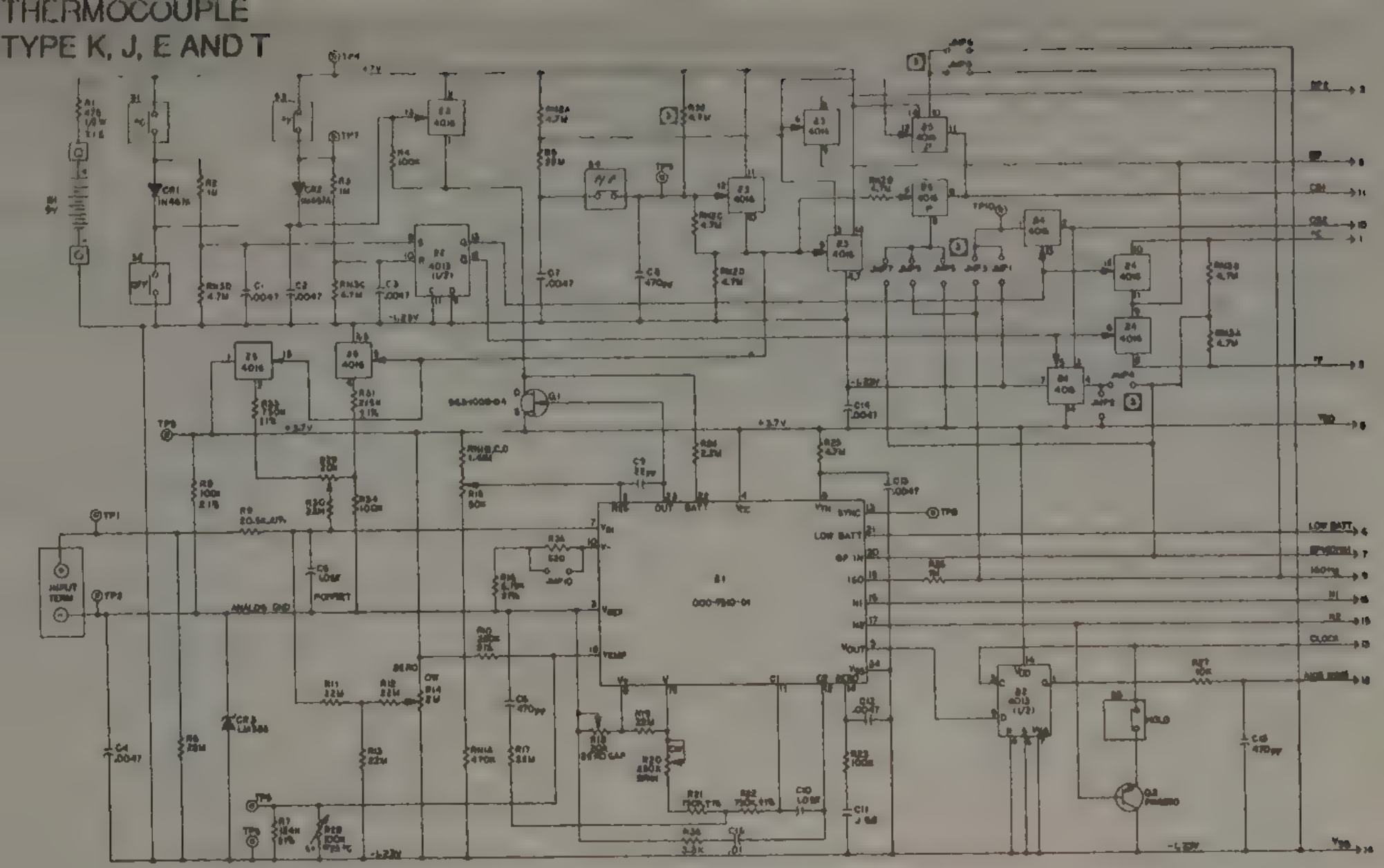
COARSE SPAN CALIBRATION COMPLETED

Section 4
Schematics

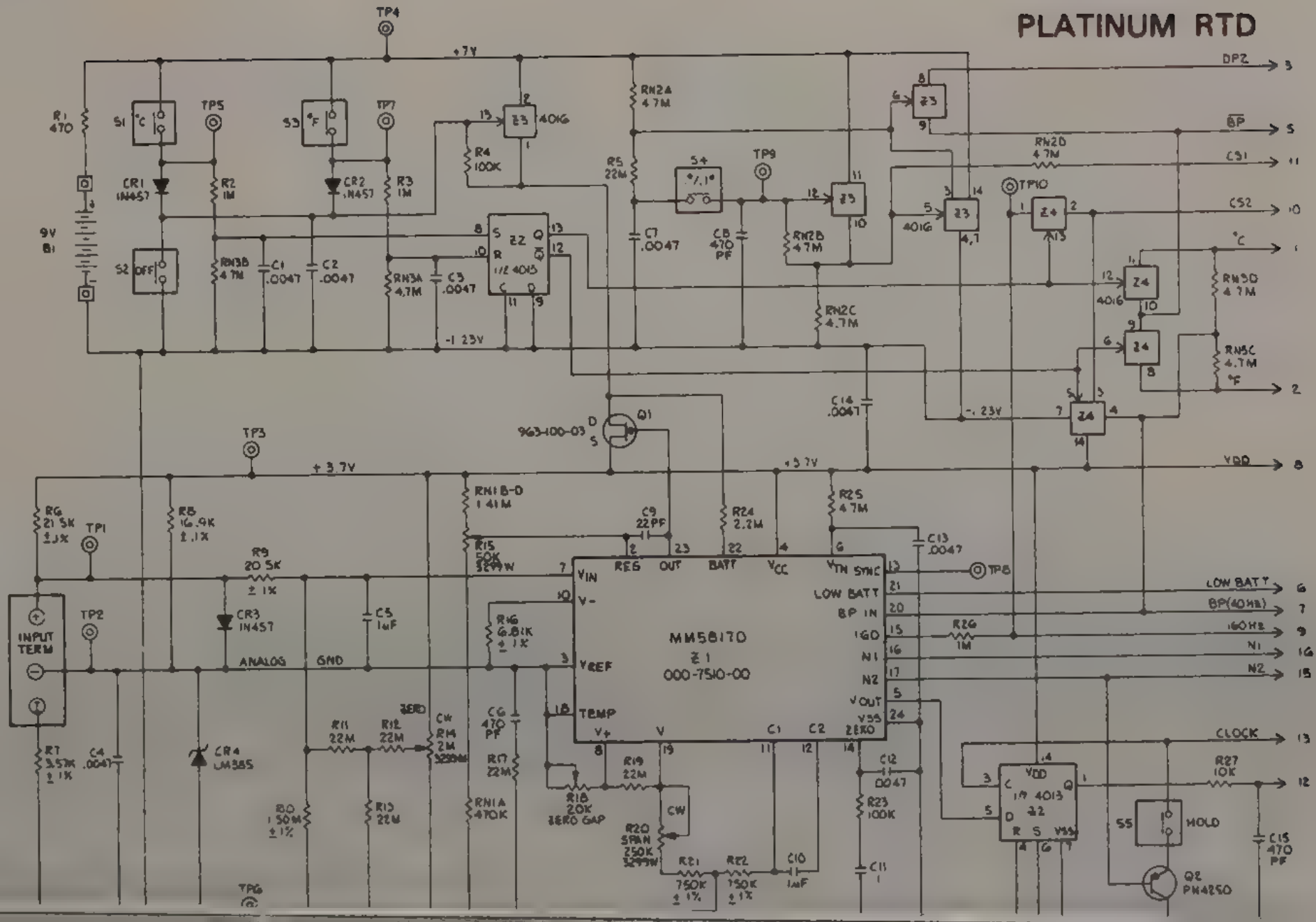
DISPLAY BOARD

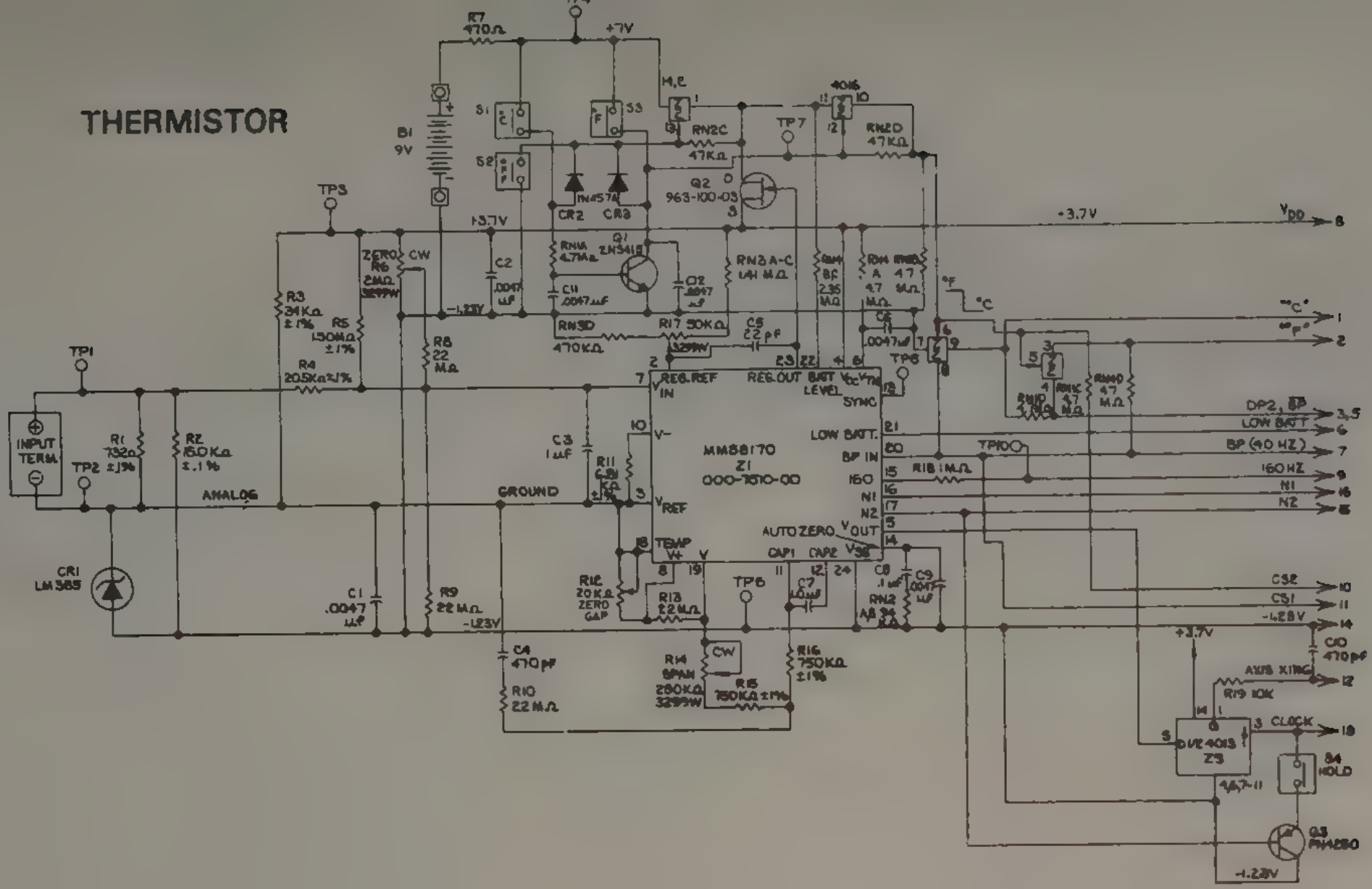


THERMOCOUPLE
TYPE K, J, E AND T



PLATINUM RTD




THERMISTOR
B1 9V
S1
S2
S3
TP3
+3.7V
CR2 IN4574
CR3
Q1 2N3416
Q2 963-100-03
TP7
RN2C 47KΩ
RN2D 47KΩ
4016
R7 470Ω
ZERO R6 2MΩ 3299W
CW
R3 34KΩ ±1%
R5 150MΩ ±1%
R4 20.5KΩ ±1%
R8 22 MΩ
C2 .0047 µF
C11 .0047µF
C12 .0047 µF
RN3A-C 1.41 MΩ
RN3D 470KΩ
R17 50KΩ 3299W
C5 22 pF
RN4 A 47 MΩ
RN4 B 47 MΩ
RN4 C 47 MΩ
RN4 D 47 MΩ
°F
°C
"C"
"F"
TP1
INPUT TERM.
TP2 ±1%
R1 732Ω
R2 150KΩ ±1%
ANALOG
GROUND
CR1 LM385
C1 .0047 µF
C3 1 µF
R11 4.99 KΩ
MM58170 Z1 000-7510-00
REG. REF IN
REG. OUT
BATT LEVEL
SYNC
LOW BATT.
BP IN
160
N1
N2
AUTO ZERO
V OUT
TEMP
CAP1
CAP2
TP6
TP10
R18 1MΩ
DP2, BP
LOW BATT
BP (40 HZ)
160 HZ
N1
N2
CS2
CS1
-4.28V
+3.7V
C8 .1 µF
C9 .0047 µF
RN2 AB 34 KΩ
R9 22 MΩ
-4.23V
R10 22 MΩ
C4 470 pF
R12 20KΩ ZERO GAP
R13 2 MΩ
R14 SPAN 200KΩ 3299W
R15 750KΩ ±1%
R16 750KΩ ±1%
C7 1.0µF
C10 470 pF
AXIS XTAL
R19 10K
CLOCK
U2 4013 Z3
S4 HOLD
Q3 PN2222
-4.28V

MP MASTER

MA26570

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